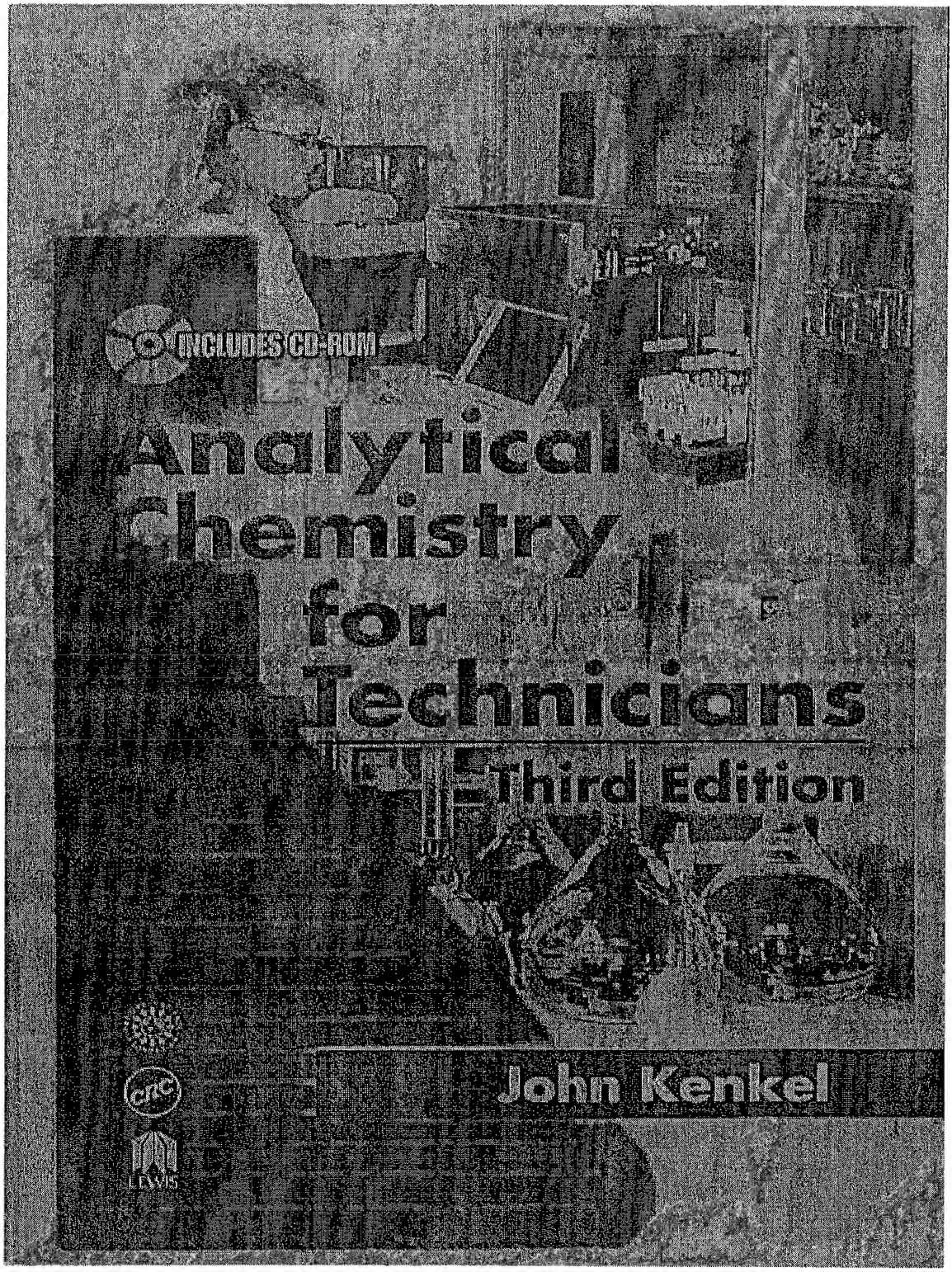
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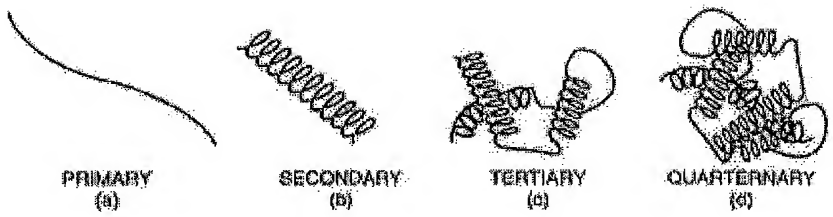

FIGURE 16.8 Conceptual illustrations of the four levels of proteins.

tertiary structures in the laboratory is slow, tedious, and in many cases presently impossible. At present, detailed information on tertiary structures exists for at most 5% of all proteins.

This tremendous diversity and complexity results from the nearly infinite number of total possible combinations of interactions stabilizing tertiary structures. R group interactions are entirely responsible. The four R group interactions are: 1) hydrophobic interactions, 2) ionic (charge) attractions, 3) hydrogen bonding, and 4) disulfide bonds between cysteine residues (amino acids in a chain). Since disulfide bonds are the only covalent linkages, their presence is deemed crucial for protein stability. The complexity of tertiary structures is derived from the sheer number of possible interactions. For example, consider a hypothetical polypeptide chain with 200 amino acids, 100 of which have hydrophobic R groups. Theoretically, any one of these 100 may form a hydrophobic interaction with any of the remaining 99. To determine the complete tertiary structure, one must prove which amino acids actually do form these interactions (e.g., position 18 with position 95).

16.2.3.6 Proteins: Quaternary Structure

This level of structure is found only in oligomeric proteins, those with multiple polypeptide chains. Myoglobin, for example, has only one polypeptide chain, and therefore has no quaternary structure. Myoglobin is the red pigmented protein in muscles that stores oxygen gas. Hemoglobin, the protein that carries oxygen from the lungs to the tissues, has four polypeptide chains, and therefore possesses a quaternary structure. This level is concerned with the interactions among chains that stabilize the three-dimensional structures needed for functional molecules. Quaternary structures result from R group interactions, frequently hydrogen bonding. A conceptual illustration of all four levels is shown in Figure 16.8.

16.2.4 Nucleic Acids

Only two nucleic acids exist. They are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). The structural complexity of nucleic acids falls far short of that of proteins. Like proteins, however, nucleic acids are polymers, with nucleotides being the monomer units.

Each nucleotide consists of three structural components: a nitrogenous base, a pentose monosaccharide, and a phosphate functional group. The bases, which are heterocyclic and aromatic, are of two types, purines and pyrimidines. Purine bases consist of a six-atom ring fused to a five-atom ring. Of the nine atoms in the fused rings, five are carbon and four are nitrogen. The common purines in DNA and RNA are adenine (A) and guanine (G). Less common purines include uric acid, xanthine, and hypoxanthine. Pyrimidine bases possess a single six-atom ring, four atoms of carbon and two of nitrogen. Pyrimidines found in DNA are cytosine (C) and thymine(T), and RNA has cytosine and uracil (U). DNA nucleotides include the pentose deoxyribose, and RNA has ribose. The linkage of any base to either pentose forms a nucleoside. Covalently linking a phosphate functional group to the pentose results in a complete nucleotide.